disorientation, anxiety and depression. Benefits on general behavior and family distress have also been reported. Graded exercises in various memory tasks, both verbal and visuospatial, have been developed and reported to improve both memory deficits and overall functioning.

Remediation of left hemisphere dysfunction has revolved principally around linguistic and communication issues. Controversy over the benefits of specific therapy for aphasia represents an older subset of the issues of efficacy of cognitive rehabilitation in general. Specific approaches to right hemisphere dysfunction, such as impaired visual scanning, decreased sensory awareness and visuospatial processing, have recently been developed. Higher level, more integrative deficits have also been addressed. Behaviorally based programs for uncooperative, unmotivated and frankly assaultive patients with brain damage have been developed and appear successful, even many years after injury. More subtle deficits of social sensitivity and behavior have also been treated with reported success.

Despite this growing number of reported successful approaches, several important questions remain about cognitive rehabilitation. The magnitude of therapeutic effect is difficult to specify. There is a significant concern over the degree to which improvement in specific elementary psychological deficits, such as basic orientation, visual scanning or mnemonic processes, even if they can be accomplished, generalizes beyond the training environment to produce meaningful overall clinical benefit. Finally, the duration of such effect is unknown. Extended follow-up studies are rare but seem to suggest reversion to baseline. Because of its specificity and minute attention to identifying specifically impaired psychological processes, cognitive rehabilitation is a labor-intensive and therefore expensive modality. Ultimate savings through reduced dependency are theoretically substantial, however. The introduction of microcomputers to do much of the daily repetitious elements of such therapy has the potential to significantly reduce the cost.

The present consensus is that more rigorous study needs to be done to clarify the above issues, but clinical experience would suggest including this element of care in selected cases of central nervous system rehabilitation.

D. N. COPE, MD
Stanford, California

REFERENCES

Ben-Yishay Y: Working Approaches to Remediation of Cognitive Deficits in Brain Damaged Persons, Rehabilitation Monograph No. 62. New York, New York University Medical Center, Institute of Rehabilitation Medicine, 1981

Bracie O, Sbordone R, Lynch W, et al: Cognitive retraining through computers: Fact or fad? Cognit Rehabil 1985; 3:10-28

Gordon WA, Hibbard MR, Egelko S, et al: Perceptual remediation in patients with right brain damage: A comprehensive program. Arch Phys Med Rehabil 1985 Jun; 66:353-359

Imes C: Cognitive rehabilitation of brain-damaged patients: An annotated bibliography. Cognit Rehabil 1985; 3:8-19

Seron X: Reeducation strategies in neuropsychology: Cognitive and pragmatic approaches, *In* Rose FC (Ed): Advances in Neurology—Vol 42, Progress in Aphasiology. New York, Raven Press, 1984, pp 317-325

Wheelchair Sports Medicine

WHEELCHAIR SPORTS MEDICINE involves the assessment of recreational and competitive sport capacities of physically disabled persons, medical classification to allow fair competition among athletes with various types and degrees of disability, the prevention, diagnosis and treatment of athletic injuries and research into the physiology and biomechanics of wheelchair athletics.

As the popularity of sports and fitness training has boomed in the United States and as wheelchairs have evolved into sleek, lightweight, efficient machines, wheelchair athletes have grown in importance and acceptance. Men, women and children with varying degrees of disability have become involved in a wide spectrum of individual and team sports including basketball, volleyball, fencing, shotput, discus, javelin, archery, slalom, wheelchair racing, marathon racing and even mountain climbing. Tennis, table tennis and bowling have become popular as sports in which disabled and able-bodied persons can play together.

The physiologic benefits of participating in sports are specific to the type of training undertaken. Wheelchair athletes can show a significant, measurable increase in endurance and cardiorespiratory performance, as well as improved skeletal muscle strength, speed, coordination, balance and flexibility. Possible psychological benefits include a positive impact on sense of competence, self-esteem, self-reliance and leadership.

Wheelchair athletes have insisted on departing as little as possible from the original version of each sport. In wheelchair basketball, for example, the baskets are not lowered. Interestingly, the wheelchair has assumed status and significance similar to the polo player's horse or the hockey player's ice skates.

Medical classification is done according to National Wheelchair Athletic Association and National Wheelchair Basketball Association rules, which require that muscle strength, sensation, spasticity, balance and deformities be assessed. As with the categorization of competitors by weight in able-bodied sports such as boxing and weight-lifting, the opportunity to compete on equal terms with others is ensured in wheelchair sports by quantifying the degree of disability. This permits persons with a similar severity of disability to compete against each other.

The most prevalent injuries sustained by wheelchair athletes are soft tissue injuries, blisters and skin lacerations or abrasions. Major injuries such as fractures or trauma leading to further permanent disability are rare. Soft tissue injuries occur most commonly at shoulders, elbows, wrists and hands. These include muscle pulls, strains, sprains, bursitis and tendinitis. Many of these injuries are recurrent. They are caused by tearing and overstretching of ligaments during falls or physical contact, by chronic overuse of muscles and tendons and by overexertion without proper warmup. Blisters of the hand and fingers are also quite common and are caused by traction or irritation of skin in contact with the wheelchair rim or tire. The skin exposed at the top of the seat post on the back of the wheelchair may also be at risk for blisters. Abrasions and lacerations of the fingers, thumbs and arms may be caused by contact with brakes or sharp edges of the wheelchair, by contact with the larger tires of track chairs or by fingers being trapped between wheels as, for example, during basketball.

Decubitus ulcers, primarily a problem among athletes with spinal cord injuries, are due to shear forces and pressure over the buttocks and sacrum. Sports wheelchairs that are designed with the knees higher than the buttocks may also contribute to the problem by increasing pressure over the sacrum and ischial tuberosities. Sweat and moisture combine with shear forces to complicate the problem.

Temperature regulation disorders are caused by an in-

ability to respond to changes in heat or cold, especially in persons with quadriplegia from spinal cord injuries.

It is important that athletic performance, which is well above average functional performance, be considered as the goal in diagnosing and treating the soft tissue injuries of the disabled athlete. Conditioning and strengthening after an injury must go well beyond the strength, power and endurance required for the performance of ordinary activities of daily life.

JULIE G. BOTVIN MADORSKY, MD
Pomona, California

REFERENCES

Jackson RW, David GM: The value of sports and recreation for the physically disabled. Orthop Clin North Am 1983 Apr; 14:301-315

Madorsky JG, Curtis KA: Wheelchair sports medicine. Am J Sports Med 1984 Mar-Apr; 12:128-132

Steadward RD (Ed): Introduction, Proceedings of the First International Conference on Sport and Training of the Physically Disabled Athlete. Alberta, Canada, The University of Alberta Department of Physical Education and The Government of the Province of Alberta, 1979, pp 1-2

Functional Electrical Stimulation

IN 400 BC Greek physicians recommended using the electric torpedo fish (family Torpedinidae) as a treatment for paralysis. In 1791 Galvani linked electrical stimulation to muscle contraction. Electrical stimulation was enthusiastically promoted in the 19th century for a variety of ailments, firmly establishing this modality in the pantheon of quackery.

Advances in electronics and neuromuscular physiology engendered more realistic applications of electrical stimulation. It is widely used as an adjunct to physical therapy (sometimes this specific clinical use is equated with all of functional electrical stimulation) and as a pain treatment modality (transcutaneous nerve stimulation). In 1961 Lieberson coined the term "functional electrotherapy" for electrical stimulation used in place of an ankle-foot orthosis for hemiplegic footdrop. Useful movement of the ankle dorsiflexors was produced by heel-switch gated stimulation of the peroneal nerve. Improvements in reliability, size, materials and computerization have led to portable and even implantable systems of remarkable sophistication. Notable are those devices for phrenic nerve stimulation, sacral root stimulation for micturition and peripheral nerve or motor point stimulation of upper extremities for hand function or the lower extremities for standing and ambulation. Strategies of sensory feedback are being investigated in some patients to give a more physiologic approximation of function.

The clinical application of these systems requires an experienced team including physicians, therapists and technicians. A fairly sophisticated level of patient and family cooperation is essential. The high current requirement and loss of neurotrophic factors in denervation (lower motor neuron paralysis) limit electrical stimulation to conditions where the motor units are intact (upper motor neuron paralysis). Extensive conditioning programs, in addition to standard rehabilitation, are needed to strengthen atrophic muscles and improve fatigue resistance of electrically stimulated muscles. This "functional electrical exercise" may have physiologic benefits in itself.

Media attention has tended to obscure the fact that these systems are electrical orthoses and do not cure underlying disease. They are appropriate only when the lower motor neuron is intact and may adversely affect recovery in cases of incomplete lower motor neuron disease. Despite this, functional electrical stimulation remains a rapidly evolving area of rehabilitation that in the near future may provide significant functional options for the severely disabled.

MICHAEL S. WEISS, MD
Stanford, California

REFERENCES

Benton LA, Baker LL, Bowman BR, et al: Functional Electrical Stimulation—A Practical Guide. Downey, Calif, Rancho Los Amigos Hospital, 1984

Brown MC, Holland RL: A central role for denervated tissues in causing nerve sprouting. Nature 1979; 282:724-726

Cardozo L, Krishnan KR, Polkey CE, et al: Urodynamic observations on patients with sacral anterior root stimulators. Paraplegia 1984; 22:201-209

Glenn WW, Hogan JF, Loke JS, et al: Ventilatory support by pacing of the conditioned diaphragm in quadriplegia. N Engl J Med 1984 May; 310:1150-1155

Solomonow M (Ed): Neuromuscular stimulation: Applications in Orthopedic Medicine. Orthopedics (special issue) 1984; 7:1111-1200

Vocational Potential in Multiple Sclerosis

MULTIPLE SCLEROSIS affects an estimated 123,000 adults in the United States, and 90% have the onset of their disease in their vocational prime, between the ages of 15 and 50. Several studies have shown an unusually high level of educational accomplishment in this population, with almost half in one study having some postsecondary education. Yet, the incidence of unemployment in the multiple sclerosis population is extremely high, and the cost of this unemployment to society is considerable.

In a study done in the United States in 1981, less than 20% of patients with multiple sclerosis were still employed 20 years after diagnosis. In a study done in West Germany in 1965, nearly a third of the patients studied were still employed 20 years after diagnosis. Yet, an Israeli study from 1981 found that more than 50% of persons with multiple sclerosis continued to work, and the study population included the entire known group of persons with this disorder in Israel at that time. The reasons for the significant national differences in percentages of employed persons with multiple sclerosis are not known. There are substantial differences between American, Israeli and German cultures, but they share enough in common to warrant study to achieve the best possible level of employment, especially with the US rate falling more than 30% short of the highest rate found.

Many problems may create vocational difficulties for a person with multiple sclerosis. Visual problems, ataxia, fatigue, mobility problems, urinary urgency and frequency and cognitive problems all can be severely disabling on the job and cause a need for substantial job modification.

The frequency of cognitive problems in persons with multiple sclerosis is high. More than 50% of patients in one recent study tested in the impaired range despite a mean diagnosed length of illness of less than seven years. Of the cognitive deficits seen, many are of considerable vocational significance. They include many frontal lobe function problems such as the loss of abstract conceptualizing skills, short-term memory and new learning ability, as well as impaired concentration and reduced insight. These problems often are clinically silent. Failure to function cognitively may lead a person to leave a job but transfer the blame to "physical difficulty." A thorough evaluation of cognitive function is useful in assessing ability and disability and in planning a vocational rehabilitative strategy. Counseling may play a very helpful role in learning to cope with cognitive disability.

Urologic problems are frequently mentioned as a problem on a job. The commonest problems reported have been ur-